

FOR CONDUCTING A MECHANICAL SLUG TEST

Date: June 12, 2017

1.0 PURPOSE

The purpose for this standard operating procedure (SOP) is to describe the field methods to be used for conducting mechanical slug tests in order to determine the hydraulic conductivity of the formation materials surrounding the screened interval of a monitoring well. This method involves measuring the response of a static water-level to either the insertion or removal of a solid cylinder (slug) into the well.

During testing, water-level changes from the static water level are measured and recorded with time. A pressure transducer and a data logger are to be used to collect slug test data as they provide a means for collecting substantial, meaningful data over a short period of time, which is needed for analysis.

The mechanical slug tests will generate data that will be used to determine the hydraulic conductivity at each well where a pneumatic slug test can't be completed, such as wells screened across the water table and not fully submerged. This data will be used for evaluation of groundwater flow beneath the Site.

2.0 CONSIDERATIONS

Mechanical slug tests will be completed at monitoring wells that do not meet the qualifications for a pneumatic slug test. In order for a pneumatic test to be conducted, the entire length of screen of the monitoring well must be submerged beneath the level of standing water in well and the screen length must be known.

3.0 EQUIPMENT AND MATERIALS

- a. Safety first. Obtain the appropriate Job Safety Analysis (JSA) and personal protection equipment (PPE), as specified in the site Health and Safety Plan (HASP).
- b. Field notebook, field forms (i.e., Daily Log and Slug Test Form).
- c. Electronic sounding device (water-level indicator).
- d. Solid plastic slug (such as water-filled PVC). The diameter and length of the slug should be determined based on the diameter of the well and the proposed displacement volume for the test.
- e. New non-adsorptive polypropylene rope of sufficient strength.

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- f. Data loggers and pressure transducers.
- g. Portable personal computer (PC) with Win-Situ software downloaded and appropriate cables.
- h. Decontamination supplies (including: non-phosphate laboratory grade detergent, buckets, brushes, potable water, distilled water, plastic sheeting, etc.).
- i. Disposable Nitrile sampling gloves and cut-proof gloves.

4.0 PROCEDURE

- 4.1. Study the well boring log to define the depth of well, well casing radius, and well boring radius.
- 4.2. Measure water levels (the depth to water below the predetermined measuring point on the well casing) in the test well to an accuracy of 0.01 foot several times prior to the slug test. If the water level is below the top of the screen, mechanical slug testing will be performed. If the entire length of screen is saturated, consider using the pneumatic slug testing technique.
- 4.3. Enter all pertinent data concerning the well to be tested on the Slug Test Form and Daily Log form, and in the field notebook.
- 4.4. Measure the total depth of the test well to an accuracy of 0.01 foot and document the measured depth. Compare the measured depth to the as-built total depth of the well to ensure no appreciable sanding or silting has occurred. If appreciable silting has taken place, consult with the project manager to confirm the test is still warranted. Wells must respond quickly to changes in water levels.

The below slug test reference tables provided by USEPA (USEPA, 2015) should be used to select the appropriate slug dimensions to achieve the target head change.

TABLE 1
Volume of Slug Required to Raise/Lower the Head Level
a Targeted Length within a Specific Well Diameter

Well Diameter (inches)	1-Foot Displacement Volume (cubic feet)	2-Foot Displacement Volume (cubic feet)
2	0.033	0.044

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TABLE 2
Slug Displacement Volume in Cubic Feet Based on
Slug Diameter and Length

Length (ft)	1.5-inch Diameter	2-inch Diameter	3-inch Diameter
2	0.025	0.044	0.098
3	0.037	0.065	0.147
4	0.049	0.087	0.196

- 4.5. Use a PVC or plastic slug that will displace the head of water within the well between the range of 0.5 to 3.0 feet. The slug should have the ability to be completely submerged within the water column throughout the test. Ensure that the slug is the appropriate volume and size based upon the above well measurements and applicable guidance documents.
- 4.6. Determine the length of pressure transducer cable needed so that the pressure transducer can be placed 2-feet below where the slug will be inserted during the test. Connect the pressure transducer to the data logger and laptop computer. Zero the pressure transducer in air. Insert the pre-cleaned pressure transducer into the well while monitoring the pressure. Secure the pressure transducer cable outside of the well to ensure the transducer depth will not shift during testing and re-zero the pressure transducer.
- 4.7. Set up the data logger with the correct recording intervals and time-steps for measurements. The data logger should be set to take measurements at the smallest increment possible, typically four measurements each second or every 0.25 seconds.
- 4.8. Attach new non-adsorptive polypropylene rope to the slug that will allow the slug to be completely submerged within the well. Ensure that the rope is properly secured to the slug so that the slug does not drop down the well. Ensure the rope is secured outside the well.
- 4.9. Lower the slug into the well just above the static water level. Do not breach the static water level yet.
- 4.10. Start the data logger to begin recording the data directly before initiating the mechanical slug-in test. Allow 5 to 10 seconds to pass before test initiation.

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- 4.11. Lower the slug below the static water level rapidly but do not let go of the rope and fully drop into the well. The slug should be entirely submerged throughout the duration of the test but should not rest upon the pressure transducer.
- 4.12. The water level will rise following the immediate introduction of the slug. Observe on screen that the data logger is recording the water-level data while water levels fall and the aquifer returns to static or near-static conditions (within 5%). Once the water level has stabilized, turn off the data logger and reprogram it for the slug-out test.
- 4.13. Start the data logger to begin recording the data directly before initiating the mechanical slug-out test. Allow 5 to 10 seconds to pass before test initiation.
- 4.14. Quickly pull the slug completely out from the water column.
- 4.15. The water level will fall following the immediate removal of the slug. Observe on screen that the data logger is recording the water-level data while water levels rise and the aquifer returns to static or near-static conditions (within 5%). Once the water level has stabilized, turn off the data logger and reprogram it for the next slug test.
- 4.16. Review the data to determine if a meaningful test has been conducted. Repeat the test once more with the same displacement value to confirm reproducibility of the data. If water levels return to static or near static conditions within one hour, conduct another test using a different level of displacement.
- 4.17. Transfer the data from the transducer and data logger to the shared network each day to ensure that the data is backed up.
- 4.18. Secure the test well prior to leaving (i.e., replace cap and/or cover, and lock).
- 4.19. All reusable sampling equipment must be thoroughly cleaned in accordance with the Roux SOP 9.1 decontamination procedures. Discard any gloves, plastic, etc. in an appropriate manner that is consistent with site conditions and regulatory requirements, and if applicable, in accordance with any site-specific investigation-derived waste management plan.

END OF PROCEDURE

REFERENCES

USEPA, December 2015. Slug Tests Standard Operating Procedures, SOP#2046.